ExoMars 2020 – AMELIA: the EDL science experiment for the entry and descent module of the ExoMars 2020 mission

Conference or Workshop Item

EXOMARS 2020 – AMELIA: THE EDL SCIENCE EXPERIMENT FOR THE ENTRY AND DESCENT MODULE OF THE EXOMARS 2020 MISSION

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Brief Presenter Biography: PI of AMELIA: EDL science experiment of the ESA ExoMars project.

She was deputy PI for the HASI instrument on the ESA Huygens probe of the NASA/ASI/ESA Cassini mission; Co-proposer/CoI of several *in situ* instruments (e.g. for Mars NetLander, ExoMars PASTEUR, M2020 MEDA, Titan, Venus). She was acting as Project Scientist of the NetLander project within the French Mars Sample Return programme at CNES (2000-2002). She has been studying planetary atmospheres and martian dust devils by in situ measurements

Abstract: The AMELIA – EDL science experiment on Schiaparelli, was officially selected by the *Joint ESA and NASA ExoMars2016 AO* (Nov 2010). AMELIA aimed at exploiting the EDLS engineering measurements for scientific investigations of Mars' atmosphere and surface [1].

Following the Schiaparelli's crash landing, the AMELIA team was part and valuably contributed to the ESA Schiaparelli Anomaly Investigation Group (SAIG) for identifying the reasons of the failure (e.g. [2], [3]). From the limited returned EDL flight data, AMELIA managed to reconstruct the correct trajectory and attitude of Schiaparelli EDM and to retrieve the atmospheric profiles and low altitude wind profiles [4]. Therefore ESA has finally decided for extending the AMELIA –EDL science proposal for application to the interpretation of the ExoMars2020 Entry, Descent and Landing (EDL) engineering data.

As per the previous mission, the experiment AMELIA 2020 will rely on the *in situ* measurements by the GNC (Guidance, Navigation and Control) sensors of the descent module: 2 Inertial Platforms (IMU) and the Radar Altimeter (RDA) and also by the ExoMars 2020 Surface Platform (SP) payload (e.g. the meteorological package MTK-L and the television camera system TSPP) and from the tracking of the radio signal during EDL.

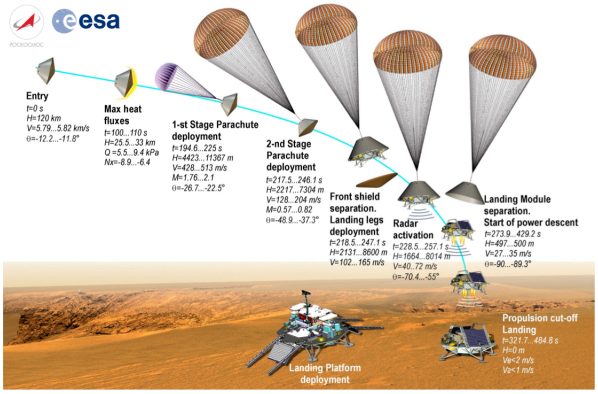

Figure 1: ExoMars 2020 EDL scenario

From the measurements recorded during entry and descent, we will retrieve an atmospheric vertical profile along the entry and descent trajectory.

Different algorithms, methods, data sets and their assimilation will be used for simulation and reconstruction of the EDM trajectory and attitude during the entry and descent phases in order to retrieve the most accurate atmospheric profile.

A near real time reconstruction of the trajectory will be done using the radio communication link between the EDM and the radio receiver on board the orbiter and by the carrier signal detection by ground telescopes. Atmospheric vertical profiles in terms of density, pressure and temperature, will be derived directly from deceleration measurements, by matching atmospheric standard model with Extended Kalman filtering (EKF) of a 6 DoF EDM dynamic model and from hypersonic dynamic pressure data recorded during entry.

The dynamical behaviour of the EDM during the descent under parachute will be modeled, simulated and reconstructed using different data, methods and data assimilation (e.g. IMU, radio link, radar, imaging and auxiliary data). Wind profile along the entry probe path will be retrieved by using the Doppler shift in the

radio link between the Descent Module and a radio receiver and by modeling the dynamic response of the pendulum system composed by the EDM and the parachute line.

Scientific analysis of the landing measurements will be aimed at the determination of the landing site context (e.g. surface mechanical characteristics, geomorphology, etc.), its characterization and assessment also in combination with remote sensing imaging.

ExoMars 2020 will provide the opportunity for new direct *in situ* measurements exploring an altitude range not covered by remote sensing observations from an orbiter. AMELIA results together with the measurements of the meteorological package MTK-L at the surface of Mars will provide a surface and atmosphere "ground truth" for remote sensing observations and important constraints for validation of Mars atmosphere models.

The experience and lessons learned in the framework of the Schiaparelli EDM and expertise in Mars observations and modelling are being put in perspective for the AMELIA ExoMars 2020 Entry, Descent and Landing (EDL) science experiment.

References:

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